Propulsion of Undersea High-Endurance Drones via Innovative Tesla-Inspired Caterpillar Drive

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Simon Edwards
Research Acceleration Initiative

Introduction

As the naval warfare paradigm shifts from the use of relatively small numbers of sophisticated high-cost platforms to one in which larger numbers of low-cost drones including kamikaze drones are employed, the ability to propel such drones despite non-feasibility of outfitting the drones with large quantities of stored energy is an important challenge to be overcome.

Abstract

Particularly in rough sea conditions, craft on the ocean find themselves adrift on an ocean not merely of water, but of untapped potential energy. Ocean swells contain remarkable amounts of potential energy and craft either at or near the surface of the ocean may, with the proper design, exploit this energy in order to achieve motion in a desired direction without self-propulsion.

The most energy-efficient and cost-effective method for achieving this end is the incorporation of a Invertible Tesla Valve Mechanism (IVTM) which one may term a "Caterpillar Drive." A Tesla Valve is a solid-state apparatus which prevents the flow of liquid through a corridor via the configuration of a series of flap-like pieces which sit at a 45-degree angle of orientation with respect to the flow direction. Ordinarily, the components of a Tesla Valve are static. If, however, a mechanically movable, large version of this mechanism were appended to the ventral and dorsal sections of an undersea drone traveling near to the surface (i.e. affected by swells,) the valve mechanism could be used in order to achieve the effect of preventing the swell from pushing the craft in one direction whilst permitting the craft to move in the other direction.

The turning of the flaps, which would require energy, could be enabled by the very same fluidic energy. The flaps would feature a locking mechanism and could be made to remain free to rotate when an inversion is called for. Releasing the locking mechanism just prior to the cresting of an ocean swell (as detected by simple accelerometer) would result in a 90-degree rotation of all flaps with little intervention. If any flaps fail to invert, a motor may assist to ensure the proper positioning of remaining flaps. Once in the inverse position, the locking mechanism would re-engage and the inverted configuration would leave the craft free to move uninhibited through the ocean.

Conclusion

This mechanism may be augmented by electrically- (battery) powered fast-oscillation of the very flaps which constitute the ITVM passive propulsion system. When bursts of greater speed are called for, an electric motor could, in an alternative mode of function, force water efficiently through the mechanism by programmatically moving one set of flaps by about 10 degrees prior to moving the second in the same direction prior to resetting the position of the primary set of flaps and then resetting the secondary flaps. Acoustically quiet drive and locking mechanisms would be called for but lie well-within the realm of feasibility.